BULLETIN OF ORBITAL INFORMATION
PART I, ORBITAL PARAMETERS

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National Center for Space Studies
Space Center of Bretigny
Division Mathematics and Processing

Translation of "La Premiere Partie: Parametres D'Orbite"
Bulletin de Reseignements Orbitaux, p. 9.

NOTICE

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
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ABSTRACT

This report details the content of information furnished in the bulletins and specifies the most rational way of using it.

I. ORBITAL PARAMETERS

I-1.

The first part gives:

- the COSPAR signal and the date of the bulletin
- the parameters of the orbit:

*Numbers given in the margin indicate the pagination in the original foreign text.

	1st column	2nd column	3rd column	4th column/2
1st line	semi-grand axis in km	drift in km per day	-	-
2nd line	Eccentricity	drift/day	-	Amplitude of long term period
3rd line	inclination in degrees	-	-	-
4th line	straight ascension of ascending node in degrees	secular term	-	-
5th line	proof of perigee in degrees	secular term	-	-
6th line	average anomaly in degrees	entire part of the number of circuits/day	fractional part	quadratic terms on the average anomaly in circuits/j^2
last line	identification of satellite	No. of revolutions	Number of Julian days since 1/1/1950	

I-2.

The parameters of the orbit in the first column are the mean parameters in the sense of the theory which has been used (Brouwer for e > 0.01, and Batrakov-Lagrange for small eccentricities).

The terms of drift given in the second column are the sum of the terms of the calculated friction and of the drift eventually left free for the metric elements and the sum of the secular terms and the terms of the drift itself (possibly) for the angular elements.

The third column gives the quadratic terms.

The fourth column gives the amplitude of the long term period to j_2, which means:

$\cos 2 (\omega_0 + \omega_1)(t-t_0))$ for e and i

$\sin 2 (\omega_0 + \omega_1 (t-t_0))$ for ω and Ω

The origin of the inertial trihedral is the same as the one adopted by the S.A.O.: the plane of the equator true equinox 1950.0. The straight ascensions of the ascending node are therefore, attributed to the trihedral.

The consequence of the drift on the semi-grand axis is reported in the computation of thr quadratic term on the mean anomaly.

Beginning with 10/9/66 the parameters will only be given with significant numbers, taking into account the estimate of errors on the parameters, given by the differential correction program. /4

I-3. Direct Information

It calls for the following comments:

- the elements are given on the date of the bulletin;

- the nodal period is the average period clear of long term periods;

- indications of magnitude are precise as a result of data furnished; by the observatory of Meudon and the observatories and stations working with Meudon, corroborated by the observations of certain amateurs;

- indications on solar activity are furnished by the SPACEWARN center of the observatory of Meudon.

II. PASSAGES IN ASCENDING NODE

The second page gives, for 15 consecutive days, the number of revolutions, the instants of the passages in the ascending node in the scale of universal time, the terrestrial longitudes of these nodes, counted positively from 0 degrees to 360 degrees eastward.

The instants of the passage in the nodes are calculated by taking into account the secular terms and drifts of the orbital elements, but not the terms of long or short periods. /5

III. DISPLACEMENT TABLES

The third page gives the displacement tables in relation to the passages in the nodes.

For the latitudes, given in the first column, the displacement is given in DT time, in minutes and seconds in relation to the instants of passage in the node, the displacement in longitude from the east in relation to the node, in degrees and decimal fractions of degrees, counted positively eastward, the altitude H in kilometers above an ellipsoid Earth, the symbol E indicating that the satellite is lighted, Z angle in degrees between the meridian, and the tangent to the trajectory (lift-off).

This table is given for two dates to permit an interpolation necessary if the satellite is eccentric.

This permits the determination at any instant of the trajectory in latitude and longitude of the satellite and to determine graphically, through a classical method mentioned in Appendix 1, the forecasts of simple passages in a given station, under the form of azimuth and elevation, with the aid of the auxiliary charts given in Appendix 2.

All inquiries for detailed information about these bulletins can be addressed to the Mathematics and Processing Division, Orbitographic-Emphemerides Group. /6

APPENDIX I.

Utilization of the passages in the nodes.
Forecasts through graphic methods.

I-1. Plotting of the projection of an orbit on the Earth.

The displacement table permits plotting, point by point, the path of the trajectory of the satellite on the Earth and to graduate it in Δt.

The step in latitude is variable to permit much easier plotting near to the parallel limit.

It is therefore sufficient to displace the obtained curve by placing the ascending node in terrestrial longitude. One gets then immediately, for a given orbit, the points of the Earth over which the satellite has flown.

I-2. Graphic forecasts

One can go farther and give the azimuth in each instant, the elevation and the distance of the satellite, measured from a station.

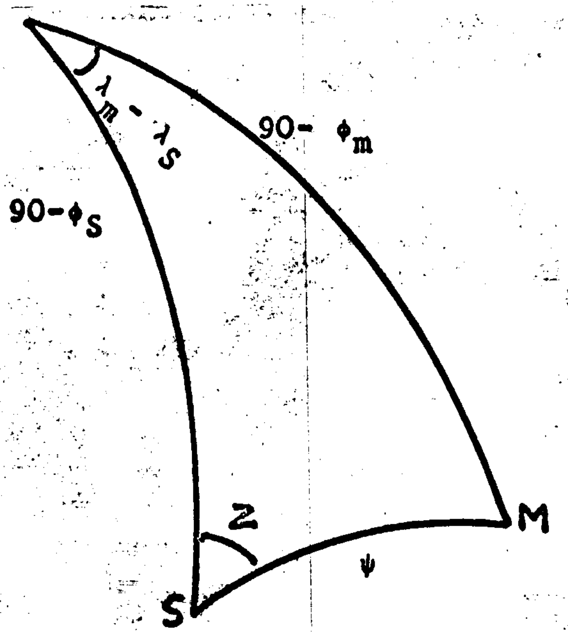
At first one traces for a given station the curves of equal azimuth and the curves of equal angular geocentric distance.

The curves can be traced point by point.

Assuming: Ψ Angle between the vectors Earth-Station and Earth-Satellite. /A-I/2

ϕ_S and λ_S latitude and longitude of the station.

ϕ_m and λ_m latitude and longitude of the present point.



$$\cos \psi = \sin \phi_m \sin \phi_S + \cos \phi_m \cos \phi_S \cos(\lambda_m - \lambda_S)$$

$$\sin \phi_m = \cos \psi \sin \phi_S + \sin \psi \cos \phi_S \cos Z$$

The symmetry in relation to the meridian has to be kept in mind.

Then one displaces the arc of the plotted orbit higher by adjusting the terrestrial longitude of the node with the help of the table indicating the passage in the node.

One reads directly on a parallel:

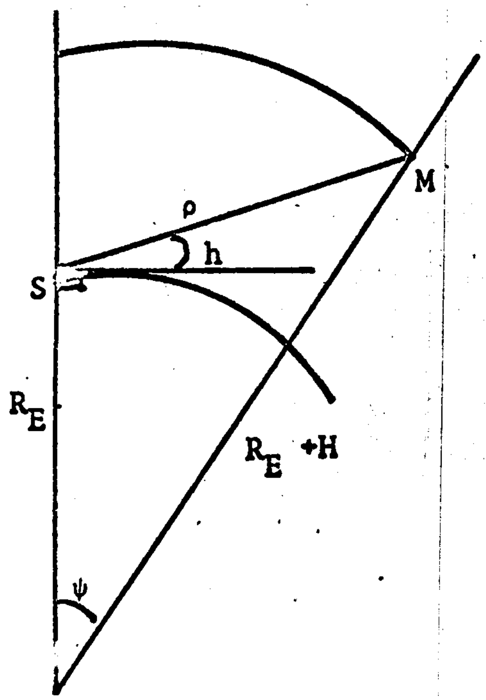
- the ΔT which, added to the hour of passage in the node gives the instant of the forecast; /A-I/3

- the azimuth at that instant is Z;

- the angular geocentric distance Ψ;

Starting from ψ and from the altitude H of the satellite (given through the displacement table) the elevation h and the distance ρ can be determined by

(R_E = radius of the Earth at latitude ϕ)



$$\boxed{\text{tg } h \sin\psi = \cos\psi - \frac{R_E}{R_E + H}}$$

$$\rho^2 = R^2_E + (R_E + H)^2 - 2R_E\,(R_E + H)\cos\psi$$

The curves established at the beginning from these formulas are given in Appendix 2.

Translated for National Aeronautics and Space Administration by INTERNATIONAL INFORMATION INCORPORATED.